ON THE HETERONEREIS STAGE OF NEREIS KOBIENSIS McINTOSH.[1]

AARON L. TREADWELL.

Among a collection of polychætous annelids made by the U. S. F. C. steamer Albatross in the Hawaiian Islands in 1902, and sent me for study, were large numbers of a heteronereid which by means of the general character of the head, the presence of a peculiar hook-shaped seta in the anterior parapodia, and especially from the form of the paragnathi, I have identified as the above-mentioned species.

Externally the bodies of both male and female individuals show very clearly the distinction between "modified" posterior, and "unmodified" anterior somites characteristic of this sexual phase of *Nereis*, the modifications following in general the usual direction, *i. e.*, a broadening and flattening of all parapodial lobes and a replacement of the ordinary form of seta by one with a very broad, flat, terminal joint. A constant external sex difference is found in the male in the dorsal cirri of somites 2–7. Beginning with somite 2 the dorsal cirrus is larger than in the female, and on successive somites as far as the seventh there is a gradual increase in the size of this organ, until on the seventh it is very prominent, composed of a thick, cylindrical basal portion; with a broad flattened tip, ending in an acute point. This condition is similar to that of the form described by Verrill under the name of *Nectonereis*.[1] On the eighth somite there is an abrupt change to the ordinary form of cirrus.

Internally, extensive modifications appear. On a surface view of a mature female, one sees that the whole body, anterior, "unmodified" as well as posterior "modified" region is crowded with eggs, seeming not to be isolated in somites, but packed together in a continuous cavity. That the transverse septæ are actually

[1] Published by permission of Hon. George M. Bowers, United States Commissioner of Fisheries.

[2] Verrill, A. E., "Invertebrates of Vineyard Sound," Bull. U. S. F. C., p. 591, 1872.

lost is indicated further by the fact that by gently pressing on the surface of the body wall, eggs may be moved from one somite to another or through several somites.

Dissection and the study of transverse sections confirm these conclusions. By the loss of the transverse septæ the whole interior of the body has been transformed into a continuous thin-walled sac, filled with ova from one end to the other. No trace of ovaries could be found, and, owing to the poor preservation of the material nothing definite can be said concerning the histology of the internal organs, but there is every indication of a considerable amount of degeneration. While the pharynx retains

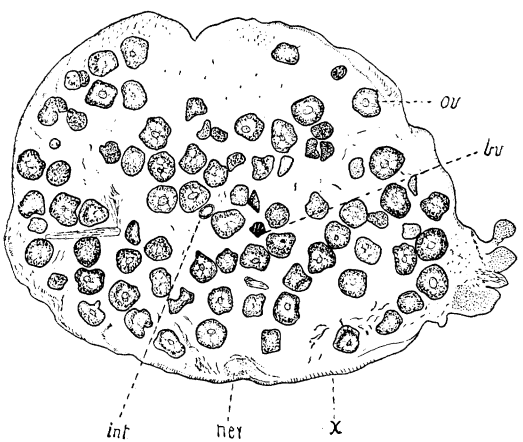

FIG. 1. Section through anterior region of body of female. × 24. *ov*, ova; *bv*, blood vessel; *int*, intestine; *ner*, ventral nerve cord.

its normal condition the intestine appears on gross dissection as a mere thread, and anteriorly, the thin transparent body wall, lacking most of its usual muscle layers, is very noticeable.

Fig. 1 is from a transverse section through the anterior end of the body, thus through the "unmodified" region. The body wall, with the magnification employed, appears as a mere line, with the thin layer of longitudinal muscle fibers showing as rows of dots just inside it. These muscle fibers are more or less broken away from the rest of the wall, but I cannot tell how much of this is due to actual degeneration, and how much to defective preservation and faulty microtome technique. A small

break in the dorsal wall is apparently due to the latter. The intestine, *int.*, Fig. 1, shows in the section as a minute tube, in whose walls no definite cellular structure could be seen. In many sections I could find no trace of the intestine. While this may possibly be due to the technique, I do not think that they could have dropped out of so many sections, and believe that there was an actual disappearance. Such a condition with respect to the intestine is not unusual among annelids at the breeding season.

Ventrally is the section of the nerve cord, and on the right a part of the parapodium is seen. The parapodial muscle bands are very feebly developed.

As shown in Fig. 1 large numbers of ova are present in the body cavity. These fill the whole cavity, extending forward into the head, so that, as is shown in Fig. 5 a section through the

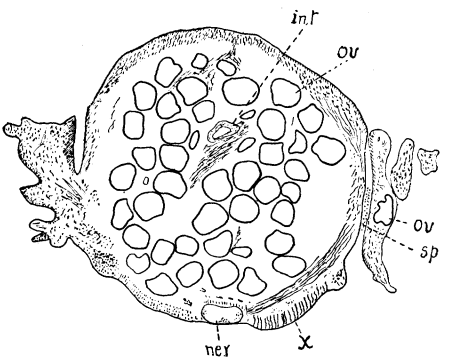

FIG. 2. Section through posterior region of same individual as in Fig. 1. × 24. *sp*, spermatozoa adhering to surface, other letters as before.

eye shows at the same time an ovum, contained in a cavity between the muscles of the head. That this condition is usual can be seen by careful surface examination of the entire annelid. The ova appear to have a very dense outer layer with vacuolated interior containing a nucleus. As it is impossible to tell how much of this apparent structure is an artefact, I have represented it only in a very diagrammatic fashion in Fig. 1, while in Figs. 2 and 5 I have drawn merely the outlines of the ova.

Scattered among the ova are many sections of connective tissue

and blood vessels, *bv*, Fig. 1, indicating that loose strands of this tissue, carrying vessels, still persist.

In the posterior portion of the body, the so-called "modified" region, similar conditions hold with respect to the septæ and intestine, but the body wall is very noticeably thicker, its muscle layers being very well developed. This is easily seen by reference to Fig. 2 which is a section through a posterior somite of the annelid drawn in Fig. 1. The longitudinal band of muscle fibers is much more strongly developed, and the oblique fibers, especially those connected with the parapodia are vastly stronger than those in the anterior somites. The difference in thickness of the body wall is especially well seen in a comparison of Fig. 3, an enlarged camera drawing of the body wall at *X* in Fig. 1, with Fig. 4, a similar drawing of *X* of Fig. 2. The dermal layer is

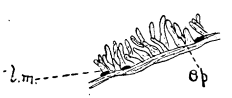

FIG. 3. Detail of ventral wall at *X* in Fig. 1. × 280. *lm*, longitudinal muscle fibers seen in section; *ep*, epidermis.

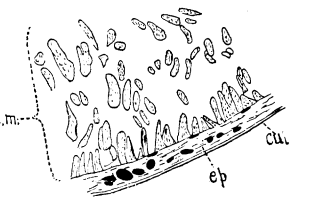

FIG. 4. Detail of ventral wall taken from the point 4 in Fig. 2. × 280. *cut*, cuticle.

much thicker, and the longitudinal band is relatively enormously developed. It will be understood, of course, that the thickness of the muscle band is indicated by the entire diameter of the figure. Owing to the irregular arrangement of the fibers no one of them extended through the bundle in a straight enough fashion to appear entire in a single section. It is evident further that the arrangement in Fig. 4 is more nearly a normal one than in Fig. 3, so that the condition of the latter must be regarded as due to degeneration.

On either side Fig. 2 shows a section of a parapodium, that on the right containing an ovum in its cavity.

Similar conditions hold in the case of the male heteronereid. The anterior "unmodified" portion of the body is more or less

degenerate as regards its body wall, muscles and intestine, while the posterior "modified" region shows at least no degeneration of its muscle structure. I am inclined to believe there has been a hypertrophy of these organs, but non-sexual individuals are not available for comparison. Spermatozoa are found all through the body, from the prostomium backward. At no place, however, does the intestine appear as degenerate as in the female. This is especially true of the posterior region, where the intestine is large, filling nearly as much of the cœlom as it does in other annelids.

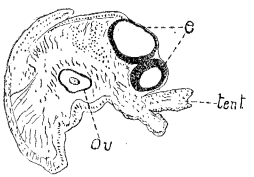

FIG. 5. Section through head of same individual. × 24. *e*, eye; *tent*, tentacle.

If the loss of the intestine has arisen in the female through mechanical reasons, connected in any way with the accumulation of large numbers of ova around it, it is easy to see why the loss should be greater in the female than in the male. Though present in large numbers, the spermatozoa would on account of their small size, occupy much less room and exert much less pressure on surrounding organs, than would the ova.

Many individuals contained no sex cells, apparently having discharged them into the water. That the sea water must have contained considerable numbers of sex cells is shown by the fact that numbers of spermatozoa are found in the sections, adhering to the body of the female. Fig. 2 represents a number of sperm adhering to the outside of a lobe of the parapodium.

As shown above, no sex organs were found. It would be of a good deal of interest to know whether they were originally present throughout the body, or are confined to the posterior "modified" end. The latter condition is much the more probable. Apparently in this annelid there is, in the heteronereis phase, a considerable degeneration of the anterior "unmodified" region, the degeneration involving the internal organs and parapodial muscles, though not especially involving the external organs. Into this thin-walled sack thus formed pass the sex-cells, which are now carried in it (as well as in the posterior portions of the body) while the posterior parapodia retain their normal muscular development and function as the main loco-

motor organs of the animal. Whether the animal goes to pieces after the sex cells are thrown off, or whether it subsequently regains its normal condition, cannot be determined by the material at my disposal.

VASSAR COLLEGE, March 3, 1905.